108a

A MONTE CARLO SIMULATION APPROACH TO THE IFRS 16 IMPLEMENTATION IN EUROPEAN COMPANIES

Begoña Giner
Professor in Accounting and Finance
Department of Accounting
Faculty of Economics
University of Valencia (Spain)

Paloma Merello
Assistance Professor in Accounting and Finance
Department of Accounting
Faculty of Economics
University of Valencia (Spain)

Francisca Pardo
Associate Professor in Accounting and Finance
Department of Accounting
Faculty of Economics
University of Valencia (Spain)

Category: A) Financial Information and Accounting Standards

Keywords: IFRS 16 · Operating leases · Monte Carlo simulation · European Union

JEL Descriptors: G32; M41; M48

A MONTE CARLO SIMULATION APPROACH TO THE IFRS 16 IMPLEMENTATION IN EUROPEAN COMPANIES

Abstract:

As a result of IFRS 16 adoption, operating lease contracts will be included in the balance sheet. Using Monte Carlo simulation, we generate predictions by incorporating uncertainty about the future value of some variables to assess its impact. Based on the Stoxx-All-Europe-100 and a five-year horizon, the as-if results confirm that debt quality, liquidity and ROA decrease in 2019, while leverage and ROE will increase; figures do not change substantially afterwards. The results of this dynamic approach are consistent with several likely scenarios about the future; however, this impact is smoothed under the strategy of reducing lease life.

1. Introduction

The European Commission (EC) endorsement process of IFRS 16 has recently ended, hence in 2019 European firms will have to apply the new standard to record lease transactions. Consequently, thinking in the post-implementation review process, now more than ever, it is relevant to provide additional analyses on the potential impact of such adoption. The accounting literature has already provided some as-if studies where operating lease contracts have been included in the balance sheet in order to estimate the impact of the change. A recent study referred to European Union (EU) Regulated Markets estimates that in 2015 the total simulated lease liability for the non-financial sectors is around €574 billion, representing 15% of total debt; however, those contracts should be included as debts in the balance sheet when IFRS 16 is applied (Europe Economics, 2017). As Labro (2015) highlights, despite its potential usefulness, the use of simulation methods is not common in accounting research, and this is the methodological approach we use to analyse the impact of IFRS 16. More precisely, we simulate its impact using the Monte Carlo method, which allows to consider complex but reasonably systems and generate predictions (e.g. Balakrishnan and Penno, 2014). Thus, by incorporating uncertainty about the future values of some variables that condition the results, this methodology helps to deal with research questions when there is no data available, as it happens with the question in-hand: Which will be the impact of IFRS 16? Despite the lack of published studies in accounting using this approach, it has been frequently used in other related fields, such as finance and economics (e.g. Boyle et al., 1997; Mody et al., 2001; Detemple et al., 2005; Reher and Wilfling, 2014; Pastor and Peraita, 2016).

Based on the Stoxx All Europe 100, we apply the Monte Carlo simulation method and provide a new as-if analysis that allows us to estimate the financial position and performance of the firms affected by the accounting change in a five-year horizon after implementing IFRS 16. In our view, the impact on companies of the Stoxx All Europe 100 could be seen as a proxy of the impact on all listed companies in the EU as well as in other jurisdictions in which firms have to apply the new standard. This study confirms that in 2019 leverage increases; debt quality and liquidity decrease; as for profitability ratios return on assets decreases while return on equity increases, however figures do not change much afterwards. Our results are consistent to the estimations based on several likely scenarios, although the impact of IFRS 16 would be lower if companies shorten the lease contracts.

Following this introduction, the next section is devoted to the institutional regulatory background. The third section deals with the literature review. The fourth

section about methodology includes the sample and research method. Section 5 contains the results and discussion, and finally we expose the main conclusions.

2. Institutional regulatory background

The current standards in force, International Accounting Standard (IAS) 17 issued in 1997 by the International Accounting Standards Committee (IASC, 1997), and adopted by the International Accounting Standards Board (IASB) in 2003, and Statement of Financial Accounting Standard (SFAS) 13 issued in 1976 by the Financial Accounting Standards Board (FASB) both require firms to distinguish between operating and finance leases. Despite the similarities, there are some differences between them, being the main difference that IAS 17 lacks the bright-line tests associated with SFAS 13 to classify a lease as finance.

In 2006, the IASB and FASB signed up a "Memorandum of Understanding" (MoU) which enhanced their commitment from a "compatible" to a "common" set of high quality standards. The MoU, which constituted a definite step forward in the convergence process, included the accounting of leases among the topics that were considered critical. The general view was that the treatment of the leases underestimated both assets and liabilities, and the classification of leases was complex and subjective. Consequently, many firms structured *ad hoc* contracts to avoid capitalizing finance leases.

Before the Boards added to their agendas a joint project on lease accounting in 2006, the topic was already under discussion; in fact, ten years earlier, in 1996 the G4+1 published a discussion paper (DP) along the same lines as the new model in IFRS 16. In 2005, the US Securities and Exchange Commission (SEC) questioned lease accounting taking into account the figures about the use of operating leases compared with those of capital leases. Thus, based on their own analysis of a sample of annual reports, approximately 63% of all listed companies reported operating leases while only 22% reported finance leases (SEC, 2005).

The IASB due process involves a series of steps, which necessarily include the publication of at least one exposure draft (ED). In this case, a DP and two ED were published, and received more than 1,700 comment letters, which indeed indicate the high attention that captured the development of the new standards. Moreover, a later stage includes a post implementation analysis that takes place two years after the implementation of a standard or an amendment. We think this paper could be especially useful for such purpose.

The Boards published a joint DP in March 2009 (IASB, 2009), which would remove the line between operating and finance leases. This DP proposed a new accounting model ("right-of-use" model) to be applied to all leases. Hence, it required recognizing an asset (that represents the right to use the leased asset for the lease term) and a liability to make lease payments. This DP received numerous criticisms, most of them from the preparers and industry organizations. Their main arguments were that the model was complex, mainly due to the accounting for contingent rentals and purchase options. They claimed that these aspects do not meet the definition of a liability as established in the conceptual framework.

The first ED issued in August 2010 followed the DP approach but made some changes (IASB, 2010); it excluded the purchase option (unlike the DP) and introduced the option of using a simplified approach for short-term leases without updating payments. The main concerns during the comment period referred to valuation of assets and liabilities, defining and establishing the lease term, the treatment of renewal options and contingent payments, and the voluntary nature of the simplification for short-term leases.

In May 2013, the Boards issued a second draft (IASB, 2013), which greatly differed from the previous one. Among other relevant changes, the new ED introduced a dual model. If a lessee is expected to consume more than an insignificant portion of the economic benefits embedded in the underlying asset, the contract is classified as Type A (most of the assets), otherwise is Type B (property). Despite the classification, there are no differences in terms of the recognition of a right-of-use asset and a lease liability, the difference lies in the presentation of the expense in the income statement.[1] As for the measurement of assets and liabilities, there were some changes compared with ED/2010/9; such as the inclusion of the purchase option, renewal and termination options (if the lessee has a significant economic incentive to exercise them), and some contingent payments (if they exist and it seems reasonable that these events will happen). Participants in comment letters showed concerns about the dual model, and the presentation of lease expense separately or combined.

Eventually, IFRS 16 was issued in January 2016 (IASB, 2016a), and Accounting Standards Update (ASU) No. 2016-02 (Topic 842) in February 2016 (FASB, 2016). Both standards have reached the same conclusions on the main

[1] For Type A leases, the unwinding of the discount on the lease liability appears as interest separated from the amortisation of the asset, but for Type B leases a single lease expense is recorded, therefore the operating profit is contaminated by the financing costs. The total lease expense is decreasing in Type A lease, and constant in Type B lease, given that depreciation expense is obtained as a difference (rental minus interest expense).

aspects and impose the capitalization of all leases, but have some differences. They follow the measurement criteria established in ED/2013/6, and none of them requires recognizing short-term leases (leases for which it is reasonably certain that the term will not be more than 12 months); IFRS 16 also has an exemption for low-value assets. The IASB follows ED/2010/9 and imposes a single model for all leases (in fact it does not refer to operating and finance leases at all). However, the FASB keeps a dual model along the lines of ED/2013/6 and retains a distinction between operating and finance leases, which affects the recognition of the lease expense in the income statement (as well as in the cash flow statement).[2] It should be noted that the accounting change also removes the lease instalments from EBITDA (earnings before interest, tax, depreciation and amortisation), which is the most widely watched measure of firms' underlying profitability. Consequently, under USGAAP, operating leases will show a lower EBITDA than finance leases (Type A in ED/2013/6), which might create some incentives for the classification. IFRS 16 was adopted in 2017 by the EC, and will be in force as of January 1, 2019.

3. Literature review

Even before any standard required the capitalization of any leasing contract, Nelson (1963) evidenced that financial ratios were negatively affected by the capitalization. In 1976, the FASB issued SFAS 13, and required to capitalize finance leases, while it only imposed disclosure in the notes of information on operating leases. The new standard motivated scholars to analyse the economic effect of such change; the early paper by Imhoff and Thomas (1988) found a decrease in finance leases versus operating leases.

The capitalization of operating leases was the focus of attention of later papers which estimated an as-if amount for the lease operating assets and the related liabilities. Different models have been used to make the estimation of the as-if figures, from a simple factor method, that multiplies the annual rental expense by a number (usually 8), to more sophisticated methods based on the operating lease commitments disclosed in the notes to the financial statements, which require several hypotheses about the existing contracts and about the future. The constructive capitalization method introduced by Imhoff et al. (1991) is probably the most sophisticated method, and has been used in different contexts; such as the United Stated of America (USA) by Mulford and Gram (2007), the United Kingdom (UK) by Beattie et al. (1998) and

[2] When the lease is classified as operating (Type B in ED/2013/6), the annual expense, which is generally constant throughout the time of the lease contract, is captured as a single expense in the income statement (as in current IAS 17).

Goodacre (2003), New Zealand by Bennett and Bradbury (2003), Canada by Durocher (2008), Germany by Fülbier et al. (2008), Spain by Fitó et al. (2013), Barral et al. (2014) —who also consider the UK—, and Giner and Pardo (2017). The general conclusion is that leverage ratios, and profitability ratios are affected, but there are differences between companies and industries, being the retail sectors the most affected. Having said that, it is not possible to compare results given the different methods, hypotheses when necessary, countries, and periods under consideration. Due to the negative impact on the ratios, it comes as no surprise that preparers have been strongly lobbying against the capitalization of operating leases. It has to be highlighted that all these studies adopt an ex ante approach, as operating leases have not been capitalized so far.

This ex ante approach has also been adopted in some recent professional studies. The PwC (2016)'s study considers 3,199 listed firms that use IFRS, and concludes that, in the EU, the median increase in debt will be around 21% and around 11% in EBITDA. Leverage (measured as debt divided by EBITDA) will increase from 1.55 to 1.78, while solvency will decrease from 46% to 41.6%. The study confirms there are important industry differences, being the impact larger in retail, airlines, professional services, health care, textile and apparel, and wholesale. Also in 2016, EFRAG published a study providing a simulation of the quantitative accounting impact on a sample of listed entities in the European Economic Area (EFRAG, 2016). Given that for a large number of entities the information on operating leases was missing, the sample is restricted to firms with the largest market capitalization and the largest operating lease commitment. The final sample used includes 417 firms. The simulated lease liability represents 4% of total debt (being the energy sector the most affected, as it is 26%); however, when the financial industry is excluded, the new liability increases to 16% of total debt. Equity is reduced by 0.6%, while excluding the financial sector the reduction is larger (0.9%). In another recent study commissioned by EFRAG to assess the impact of IFRS 16, Europe Economics (2017) focuses on EU Regulated Markets. It identifies 2,212 firms that disclose information on operating lease (out of 2,294 firms that have this type of contracts). The simulated debt liability is around €574 billion in 2015, which represents 15% of total debt, excluding banks, insurance and financial services. Hence, on average leverage will increase from 0.8 to 1, and the debt/asset ratio from 28% to 32%. The effects analysis of the IASB was also issued in 2016; it is based on a sample of 1,022 firms that use IFRS (of which 348 are European), and concludes that the average increase in liabilities will be $1661.8 billion which is about 5.4% of total assets, while in the airlines, retailers, travel and leisure it increases up to

20% (IASB, 2016b). It should be highlighted that the EFRAG's report is the only one that considers the financial industry.

The IASB's effects analysis highlights the US$3 trillion of off-balance sheet (OBS) lease commitments, which, according to current regulations, are disclosed by listed companies that use either IFRS or US General Accepted Accounting Principles (GAAP). This large amount of off-balance sheet debt is concentrated in the air, retail, travel and leisure sectors (IASB, 2016b). The extent to which their incorporation in the financial statements may have economic consequences and affect market prices, debt and remuneration contracts, among others, is the underlying question that drives this type of analysis.

In a report published by Deloitte (2011), 284 executives were surveyed to assess the potential impact of the proposed revisions to lease accounting, not only on their company but also in the broader real estate market. The general opinion is that the new standard will have material impact on key financial ratios; thus, 68% of respondents consider the leverage ratio (debt to equity) will increase, and more than 40% of respondents believe the new standards would make it more difficult to obtain financing. Besides, 49% of respondents also consider return on assets will be affected.

Leaving aside other explanations for lease contracts, it has been contended that the volume of operating leases has grown because of the existing accounting standards, while finance leases have continued to decrease (Cornaggia et al., 2013). In other words, firms design ad hoc contracts to avoid the capitalization (Imhoff and Thomas, 1988; Duke et al., 2009; Beatty et al., 2010; Bryan et al., 2010; Dechow et al., 2011), which can be seen as an attempt to distort the firm financial statements (SEC, 2005). Abdel-Khalik (1981) was probably the first author that stated firms opt for operating leases to avoid the violation of restrictive debt covenants, and it has been documented later on as well (Beneish and Press, 1993; Nikolaev, 2010; Franz et al., 2014). Furthermore, operating leases are more common in financially constrained firms, as Giner and Pardo (2017) evidence for Spain.

Despite previous studies confirm some ratios will be affected by the new accounting model introduced in IFRS 16 for operating leases, it cannot be stated that there will be a breach in covenants, and it will require renegotiations. It would be necessary to have detailed information about the content of those contracts to know how firms will be really affected by the new standard. In the Deloitte (2011)'s study mentioned above, 44% of respondents believe that the impact on financial ratios would affect their company's existing debt covenants, while 32% do not think it will happen. Another important result is that 42% of respondents think the new standard will lead to

more leases with shorter terms (and 28% consider potential lessees will decide to purchase rather than lease). Having said it, Demerjian (2011) and Paik et al. (2015) sustain that off-balance liabilities are already considered when establishing the covenants, hence the change should not convey any impact. Along these lines, Europe Economics (2017) concludes that, despite the different current treatment for operating and finance leases, market users seem to take operating lease liabilities in their current decision-making.

4. Methodology

4.1. Sample and financial ratios

The sample is made of the companies included in the Stoxx All Europe 100 index at the beginning of 2016. This index includes the 100 largest companies in the euro area; as in most of prior studies financial and insurance sectors have been excluded, which reduced the sample in 26 firms. Given that two companies do not report on the future operating lease obligations, complete information is available for 72 companies. The data are recorded for the period 2011-2015. The final sample is composed of 357 observations, as there is one company in which only two years are available. The companies in the sample are grouped into six sectors (Table 1, Panel A).

The data have been obtained from the notes to the financial statements and from Orbis database. Particularly the information about future minimum lease payments has been manually collected since, according to IAS 17, lessees have to provide the following information in the notes: *i*) payments due the year after reporting; *ii*) payments due in the period two to five years after reporting; and *iii*) payments due after five years. Given that not all firms prepare the information in the same currency, the historical exchange rate at each closing date (European Central Bank) has been used to convert them into euros.

To appreciate the impact of the accounting change, we have selected five financial ratios, which capture different dimensions of firm performance and the financial position, and have been used in prior papers (e.g., Durocher, 2008; Fitó et al., 2013; Giner and Pardo, 2017). The ratios considered are,

$$Leverage = \frac{Total\ Liabilities}{Equity + Total\ Liabilities}, \quad (1)$$

$$Debt_{quality} = \frac{Current\ Liabilities}{Total\ Liabilities}, \quad (2)$$

$$Liquidity = \frac{Current\ Assets}{Current\ Liabilities}, \quad (3)$$

$$ROA = \frac{EBIT}{Average\ Total\ Assets}, \quad (4)$$

$$ROE = \frac{Net\ Income}{Average\ Equity}. \quad (5)$$

where ROA is return on assets; ROE is return on equity; and EBIT is earnings before interest and taxes.

Ratios (1) and (2) are related with the firm financial structure; while ratio (3) analyses the capacity of companies to deal with their short-term debts; and ratios (4) and (5) measure another dimension, firm performance either from the total firm perspective as a whole, ROA, or from the shareholders' perspective, ROE.

In order to generalize the results of the analysis to all listed companies in the EU, we compare the composition of our sample to the rest of the European listed companies. In the EU listed companies, observations without available information and some outliers have been removed; specifically, cases with negative equity and all cases in which at least one of the following restrictions is not met: -10≤ROA≤10, -25≤ROE≤25, liquidity≤52, leverage ≤0.989. These restrictions are the result of applying the common practice of detecting outliers by determining an interval spanning over the mean plus/minus three standard deviations, and excluding those observations that exceed. Since the Stoxx All Europe 100 sample is made of the largest companies in Europe, we also restrict the EU listed sample to those that are not small undertakings following the Directive 2013/34/EU criteria (this is that the total assets figure exceeds €4 million and the net sales figure is higher than €8 million).

(Insert Table 1 over here)

As Table 1 evidences, both samples differ in various ways. Regarding the industry structure in Panel A, considering those industries that normally have a larger proportion of operating leases, the percentage of firms in the retail sectors is smaller in the selective Stoxx All Europe, but it is larger in Transportation, Communication, and other related sectors. As for the information on Panel B, the average firm in the Stoxx All Europe 100 is more than twenty-seven times larger in terms of total assets than other European listed firms, which is not surprising, as the former group includes the largest listed firms in the euro area. Furthermore, those largest firms are much more profitable, the average ROA is twice as much the one of the rest of listed firms, and

ROE is about five time bigger, but median figures of ROA are no so different, 6.6% - 5.4% (in the Stoxx All Europe and the other sample, respectively). However, they have more or less the same leverage ratio, 0.6-0.5 in the two samples; and debt quality and liquidity are different, but differences are moderate.

4.2. Capitalization model

This study simulates the impact of the capitalization of operating lease contracts in a 5-year period starting in 2019. This implies a big difference with prior as-if studies, which only simulate the implementation in the year under analysis. Moreover, the Monte Carlo method also allows making changes in the assumptions about future; hence, for the first time, several scenarios are considered.

We use the constructive capitalization model to reflect the impact of operating leases on the balance sheet, as if they were recognized from its inception. This method imposes assumptions regarding each single operating lease contract to obtain the present value of the future minimum lease payments (*mlp*) and the value of leased assets. Unlike heuristic methods, the difference between the lease asset and the liability during the lease term causes a decrease of the equity position and an adjustment of deferred taxes.

Some general assumptions of the method are: (*i*) at the inception of each contract, the value of the lease asset is equal to the value of the lease liability and equal to the present value of the future lease payments; (*ii*) at the end of the lease, the book values of the asset and liability are zero; (*iii*) straight-line method is used to amortize assets; (*iv*) all lease payments are made at year end; (*v*) lease payments are constant over the lease term; and *vi*) as the company is a going concern, the operating lease portfolio will be constantly renewed, so we assume that assets are in the middle of their useful life.

Regarding the lease contracts, it is necessary to calculate the minimum lease payments per year. Let us call $mlp(t)_y$ the minimum lease payment in time t for all the lease contracts existing in year *y*. Based on the sample data, and given that firms do not report detailed information of $mlp(t)$ for $t>5$ in the notes to the financial statements, the remaining life of the lease contracts is obtained by rounding up the result of dividing the total future payment reported for $t>5$, by the amount of the fifth year.

Furthermore, we also introduce some specific assumptions to operationalize the model. Thus, the remaining life of any contract (*RL*) is 9, which is the average of the sample under study; as for the discount rate, we use 5%, as Giner and Pardo (2017) evidence results remain consistent to the use of company-time specific rates vs this rate; regarding the tax rate, we use the median of the effective tax rates of the sample, 23.86%, obtained as tax expense divided by earnings before taxes.

Based on the established model, the liability adjustment is,

$$adjustment_L = \left(mlp(1) \times (1+i)^{-1}\right) + \left(mlp(2) \times (1+i)^{-2}\right) + \left(mlp(3) \times (1+i)^{-3}\right) + \ldots + \quad (6)$$

,

where *i* is the discount rate.

The asset adjustment is,

$$adjustment_A = R \times adjustment_L, \quad (7)$$

and *R* is,

$$R = \frac{RL}{TL} \times \frac{1-(1+i)^{-TL}}{1-(1+i)^{-RL}} \quad (8)$$

where *RL* is the remaining lifetime of the lease contract; *TL* is the total life of the lease contract, and $RL = 0.5 \times TL$.

The liability adjustment net of taxes is,

$$net_{adjustmentL} = adjustment_L - \left(adjustment_L - adjustment_A\right) \times t, \quad (9)$$

where t is the effective tax rate.

Based on those figures, the current and non-current liability adjustments, as well as the equity adjustment are calculated as,

$$net_{adjustmentCL} = \left(mlp(1) \times (1+i)^{-1}\right) - \left[\left(mlp(1) \times (1+i)^{-1}\right) - R \times \left(mlp(1) \times (1+i)^{-1}\right)\right] \quad (10)$$

,

$$net_{adjustmentNCL} = net_{¿} - net_{adjustmentCL}, \quad (11)$$

$$adjustment_E = \left(adjustment_L - adjustment_A\right) \times (1-t), \quad (12)$$

The balance sheet figures after capitalizing operating leases are,

$$CA_a = CA_o, \quad (13)$$

$$NCA_a = NCA_o + adjustment_A, \quad (14)$$

$$CL_a = CL_o + net_{adjustmentCL}, \quad (15)$$

$$NCL_a = NCL_o + net_{adjustment\,NCL}, \quad (16)$$

$$E_a = E_o - adjustment_E, \quad (17)$$

where CA_o is original current assets; NCA_o is original non-current assets; CL_o is original current liabilities; NCL_o is original non-current liabilities; and E_o is original equity. After operating lease capitalization, CA_a is adjusted current assets, NCA_a is adjusted non-current assets, CL_a is adjusted current liabilities, NCL_a is adjusted non-current liabilities, and E_a is adjusted equity. These figures are the components of ratios (1) to (5).

4.3. The Monte Carlo method

The Monte Carlo method is a computational algorithm that relies on repeated random sampling (Valencia et al., 2013), directly simulating the underlying process of the variable of interest and, then, calculating the average result of the process as,

$$a_m = \frac{1}{r}\sum_{i=1}^{r} x_i, \quad (18)$$

where, a_m is the average result of the Monte Carlo method for the variable of interest a, x is the individual result of each simulated observation and r is the number of simulations (runs). The selection of a sufficient number of runs is needed to generate meaningful and reliable results.

The Monte Carlo result is a consistent and unbiased estimator. Under this method, the average obtained by the simulation process converges to the population average with a speed $\frac{b_m}{\sqrt{r}}$, where b_m is the estimated standard deviation. The estimated variance takes the form,

$$b^2_m = \frac{\sum_{i=1}^{r} (x_i - a_m)^2}{r-1}, \quad (19)$$

Thus, the confidence intervals are obtained as follows. With probability=95%, the unknown expected value a lies in the interval,

$$\left[a_m - \frac{1.96\, b_m}{\sqrt{r}}, a_m + \frac{1.96\, b_m}{\sqrt{r}} \right], \quad (20)$$

In this paper, 11,000,000 runs are performed, since from this number of runs the improvement of the result does not compensate the computational cost. In our model, the estimated standard deviation of the ratios (1) to (5), for $r = 11{,}000{,}000$, are 0.264, 0.122, 1.630, 0.148 and 0.531, respectively.

The simulation time horizon is from 2019 to 2023. Besides, 2018 is simulated as the year of origin as it provides necessary data in 2019 to calculate the ratios (4) and (5) that involve averages. It should be considered that along the simulation period, some contracts might be early cancelled and others expire (when the lifetime ends), while new contracts are signed.

The model has been written and implemented in the calculation software Wolfram Mathematica 11.0.

5. Results and discussion

5.1 Numerical results of Monte Carlo simulation

To estimate the effect of IFRS 16 on the aforementioned financial ratios, simulations of the main accounting figures are performed for 2019-2023 period. The minimum lease payments in t for all lease contracts existing in year $y\left(mlp(t)_y\right)$ are affected each year by its annual variation $Vmlp(t)$. Let us be $Vmlp(t)$ the annual variation of the minimum lease payments in t due to new contracts and/or cancellations. Thus, $mlp(t)_y = mlp(t+1)_{y-1} + Vmlp(t)$. Note that $Vmlp(t)$ can be negative if there are more cancellations than new contracts (except for $t = RL$).

The simulation procedure is as follows:

i) Random variables are generated from the best-fit distributions (see Table 2, Panel A).

ii) Balance sheet and lease related variables ($mlp(t)$ and $Vmlp(t)$¿ are simulated from the equations in Table 2, Panel B, for 2018.

iii) All those cases in which any of the balance sheet and lease related variables ($mlp(t)$ or $Vmlp(9)$¿ is negative are deleted.

iv) For y>2018, mlp are simulated as,

$$mlp(1)_y = mlp(2)_{y-1} + Vmlp(1),\ mlp(2)_y = mlp(3)_{y-1} + Vmlp(2),\ \ldots, \tag{21}$$
$$mlp(8)_y = mlp(9)_{y-1} + Vmlp(8),\ mlp(9)_y = Vmlp(9).$$

v) The constructive capitalization model is applied to the simulated data, expressions (6) to (17).

vi) Financial ratios, expressions (1) to (5), are calculated for each year and for the simulated data before and after applying the capitalization model.

vii) According to the restrictions applied to the sample of EU listed companies (section 4.1), cases in which these restrictions are not met are eliminated.

viii) The arithmetic mean of each ratio is calculated, for each year and for the simulated data before (IAS 17) and after applying the capitalization model (IFRS 16).

(Insert Table 2 about here)

From the sample data, the different accounting figures, this is, the balance sheet groupings (i.e., non-current assets, current assets, equity, non-current liabilities and current liabilities), EBIT, and net income, as well as $mlp(t)_y$ and $Vmlp(t)$ are modelled using simple linear regression with ordinary least squares (OLS) approach (see Table 2, Panel B). Using a trial error approach, it is determined that current assets (CA) is the origin variable providing the best fitting results.

Logarithms have been taken in cases in which the errors presented heteroscedasticity. However, the hypothesis of normality of the errors does not need to be satisfied in this case, since the stochastic disturbances will be simulated according to the probability distribution with higher goodness of fit.

Notice that, according to $mlp(t)_y$ definition, $mlp(7)_{2018}=mlp(6)_{2018}$, $mlp(8)_{2018}=mlp(6)_{2018}$, $mlp(9)_{2018}=mlp(6)_{2018}$. Thus, $Vmlp(7)=Vmlp(6)$ and $Vmlp(8)=Vmlp(6)$.

All stochastic variables (CA and the OLS regression errors) are fitted to a probability distribution. Only non-significant different distributions (p-value>0.05), according to Pearson Chi Square or Cramer Von Mises values are selected. Those aforementioned methods test the null hypothesis that the distribution of the sample data and the theoretical distribution proposed are coincident. When more than one distribution is non-significantly different, the one with the minimum Akaike Information Criterion (AIC) is selected.

After identifying the underlying distributions of the data, distribution parameters have been estimated with random sampling with replacement (bootstrap) to ensure the robustness and stability of the estimations (Mitchell and Stafford, 2000;

Simar and Wilson, 2000). The distributions fitted to the stochastic variables of the model, as well as the main parameters of the fitting, are presented in Table 2, Panel A.

Table 3, Panel A, presents simulated ratios and the variations assuming that the application of IFRS 16 will not affect the structure of operating lease contracts (base scenario). The first row shows the simulation results for each ratio applying IAS 17 (before operating lease capitalization), as the benchmark; the other rows indicate the results applying IFRS 16 per year and the changes in the ratios with respect to that benchmark. After the capitalization, leverage increases by 4.1% in 2019, while debt quality and liquidity decrease by 5.3% and 12.3%, respectively; as for profitability ratios, while ROA decreases by 6.2%, ROE improves by 4.1%. In general, the results are rather stable in the following years.

(Insert Table 3 about here)

The simulated ratios before and after the capitalization are also shown in the two Panels of Figure 1, where the dotted lines capture the variability due to the application of IFRS 16.

(Insert Figure 1 about here)

5.2 Other future scenarios

In prior estimation, we have assumed that the introduction of IFRS 16 will not affect the structure of operating lease contracts (base scenario), but this is just one of the multiple future scenarios. It is quite likely that lessees renegotiate existing contracts, or prepare new ones under different conditions in order to reduce the impact of the new standard on the financial statements. As discussed earlier, some users consider that those changes might affect covenants or compensation bonuses with high employees, among other contracts.

According to a questionnaire survey to UK users and preparers, both groups believe that lease terms would become shorter if operating leases were capitalized, and some preparers argue lease finance would be less attractive (Beattie et al., 2006). In the Deloitte (2011)'s study, 40% of respondents thought the new lease standard would lead to leases with shorter terms. Europe Economics (2017) concludes that lessees will be incentivized to seek solutions that minimize the value of reported operating leases. Around 60% of the interviewees replied they might shorten the new contracts, and enter into ones with more variable payments, or which could be

interpreted as services rather than leases (the last two transactions are not recognized in the balance sheet).

Based on those results, we consider two scenarios that predict shorter lives. Under the first scenario (*i*), we assume that there will be no payments after 5 years for new lease contracts. Let us define $Vmlp_t(i)$, for $t \geq 5$, the amount (millions of euros) of new contracts with remaining life t years in scenario (*i*), as:

$$Vmlp_5(i) = Vmlp(5),\ Vml\ p_6(i)_{\square} = 0,\ Vml\ p_7(i)_{\square} = 0,\ Vml\ p_8(i)_{\square} = 0, \quad (22)$$
$$Vml\ p_9(i)_{\square} = 0\ , Vmlp_5(i) \geq 0,$$

in scenario (*i*) $mlp(t)$ for $t \geq 5$ are defined in Table 4.

Under the second scenario (*ii*), in addition to the assumption of scenario (*i*), the possibility of renegotiating the remaining life of the existing lease contracts is considered. Hence, those contracts that previously had a remaining life of 6, 7, 8, and 9 years will be shortened to 5 years. Thus, $mlp(t) = 0$ for $t \geq 6$*;* and $Vmlp_t(ii)$ for $t \geq 5$ as in expression (22) (see Table 4).

(Insert Table 4 about here)

Note that, as TL and RL change, equation (8) has to be reformulated each year in scenarios (*i*) and (*ii*).

Furthermore, it seems reasonable that, since under IFRS 16 variable lease payments are not included in the measurement of the lease liability (unless they depend on an index or a rate); firms have an incentive to agree a greater proportion of this type of payments in their new lease contracts. In addition, in accordance with IFRS 16, shorter than twelve-month lease contracts are exempt from being capitalized. Therefore, we assume two other possible scenarios; scenario *(iii)*, in which 20% of the total amount of new contracts will be variable payments; and scenario *(iv)*, in addition to that, 20% of the new contracts will be replaced by short-term lease contracts. These scenarios are modelled as follows,

$$Vmlp_1(iii) = 0.8 \times Vmlp(1), Vmlp_2(iii) = 0.8 \times Vmlp(2), \quad \ldots, \quad (23)$$
$$Vmlp_9(iii) = 0.8 \times Vmlp(9),$$

$$Vmlp_1(iv) = 0.6 \times Vmlp(1), Vmlp_2(iv) = 0.6 \times Vmlp(2), \quad \ldots, \quad (24)$$

$$Vmlp_9(iv) = 0.6 \times Vmlp(9).$$

Figure 2 exhibits the behaviour of the three most representative ratios, before, this is with IAS 17, and after lease capitalization for the five scenarios. Confidence Intervals (CIs) have been calculated with expression (20), but the 95% CIs are only represented for the base and (*ii*) scenarios. Note that the width of the CI depends on the standard deviation of the ratio, thus the CIs for leverage, in Panel A, are almost imperceptible. Indeed, the new scenarios convey additional results. The leverage ratio increases in all scenarios (significant at 5%), although it remains below the base scenario. Note that significant differences in ROA and ROE compared with the base scenario are obtained for scenario (*ii*), since 95% CIs do not overlap with the CIs base scenario (Panels B and C). However, no substantial differences are found in scenarios (*iii*) and (*iv*) with respect to the base scenario for ROE.

In summary, the strategy of reducing the life of leases, which is mainly captured in scenario (*ii*), will reduce the impact of the entry into force of IFRS 16.

(Insert Figure 2 about here)

Table 3, Panel B, provides the variation (in percentage) in the five selected ratios under the four scenarios explained above, compared with the simulation results applying IAS 17 (first row in Panel A).

Given the existing accounting literature does not provide dynamic results and estimations of the impact of different lease policies after the entry into force of IFRS 16, we cannot make comparisons.

6. Conclusions

This paper has employed the Monte Carlo simulation method to capture the impact of implementing IFRS 16. This can be seen as a contribution of the paper, as despite the potential usefulness of simulation methods, they are not common in accounting research. The method used allows considering complex situations for which there is no available data, incorporating the uncertainty about the future in the estimations. In addition, we claim this is a policy relevant paper that could be useful after IFRS 16 is implemented in the post-implementation review of the new standard. Our results support the idea that, with the exception of the first year, there will not be additional impact on the key financial ratios. Indeed, in 2019, as in other as-if more traditional studies, leverage will increase and debt quality and liquidity ratios will decrease; while

the impact on profitability ratios will vary; thus, return on assets will decrease while return on equity will increase. Moreover, our dynamic approach provides results that are rather consistent to several likely estimation scenarios, in which we consider changes in the contracts to reduce the impact of lease capitalization on the balance sheet. However, we identify significant differences under the strategy of reducing the life of leases, as it will smooth the impact of the new treatment for lease contracts. Although the study is based on companies in the Stoxx All Europe 100 index, we think that the results can be useful for similar firms in other contexts.

Nevertheless, this study is not without limitations. First, to improve the comparability of results between scenarios and narrow the simulation error, further simulations increasing the number of runs could be performed, but this is always a cost-benefit decision that has to be made. Second, as in any estimation, this study is subject to a number of assumptions to apply both the constructive method and the Monte Carlo method.

References

Abdel-Khalik, A.R. (1981). *The Economic Effects on Lessees of FASB Statement No. 13, Accounting for Leases*. FASB. Stamford, CT.

Balakrishnan, R. & Penno, M. (2014). Causality in the context of analytical models and numerical experiments, *Accounting, Organizations and Society* 39, 531–534.

Barral, A., Cordobés, M., & Ramírez, J. (2014). Los arrendamientos operativos: impacto de su reconocimiento en los estados financieros y en la política de financiación de las compañías españolas y del Reino Unido. *Spanish Accounting Review / Revista de Contabilidad*, 17 (2), 212–223.

Beattie, V., Edwards, K., & Goodacre, A. (1998). The impact of constructive operating lease capitalisation on key accounting ratios. *Accounting and Business Research*, 28 (4), 233–254.

Beattie, V., Goodacre, A., & Thomson, S.J. (2006) International lease-accounting reform and economic consequences: The views of U.K. users and preparers, *The International Journal of Accounting*, 41, 75– 103.

Beneish, M., and Press, E. (1993). Cost of Technical Violation of Accounting-Based Debt Covenants. *The Accounting Review*, 68, 233–57.

Beatty, A., Liao, S., & Weber, J. (2010). Financial Reporting Quality, Private Information, Monitoring, and the Lease-versus-Buy Decision. *The Accounting Review*, 85 (4): 1215–1238.

Beneish, M., & Press, E. (1993). Cost of Technical Violation of Accounting-Based Debt Covenants. *The Accounting Review*, 68, 233–57.

Bennett, B.K., & Bradbury, M.E. (2003). Capitalizing non-cancelable operating leases. *Journal of International Financial Management & Accounting*, 14 (2), 101–114.

Boyle, P., Broadieb, M., & Glasserman, P. (1997). Monte Carlo methods for security pricing. *Journal of Economic Dynamics and Control*, 21, 1267-1321

Bryan, S.H., Lilien, S., & Martin, D.R. (2010). The Financial Statement Effects of Capitalizing Operating Leases. Assessing the Impact of the Right-to-Use Model. *The CPA Journal,* August, 36–41.

Cornaggia, K.J., Franzen, L.A., & Simin, T.T. (2013). Bringing assets onto the balance sheet. *Journal of Corporate Finance*, 22, 345–360.

Dechow, P.M., Ge, W., Larson, C.R., & Sloan, R.G. (2011). Predicting material accounting misstatements. *Contemporary Accounting Research*, 28 (1), 17–82.

Deloitte (2011). How prepared is your organization to cope with these new standards? A Deloitte survey on the FASB's proposed changes to lease accounting standards. Available at: http://www.iasplus.com/en/binary/usa/1102usleasessurvey.pdf.

Demerjian, P.R. (2011). Accounting standards and debt covenants: Has the "balance sheet approach" led to a decline in the use of balance sheet covenants? *Journal of Accounting & Economics*, 52, 278–202.

Detemple, J., Garcia, R., & Rindisbacher, M. (2005). Intertemporal asset allocation: A comparison of methods. *Journal of Banking & Finance,* 29, 2821–2848.

Duke, J.C., Hsieh S.-J., & Su, Y. (2009). Operating and synthetic leases: exploiting financial benefits in the post-Enron era. *Advances in Accounting*, 25 (1), 28–39.

Durocher, S. (2008). Canadian evidence on the constructive capitalization of operating leases. *Accounting Perspectives*, 7 (3), 227–256.

EFRAG (2016). IFRS 16 Leases. Quantitative assessment of accounting impacts. July. Paper 08-02.

Europe Economics (2017). Ex ante impact assessment of IFRS 16. February.

Financial Accounting Standards Board (2016). *Leases Accounting Standards Update (ASU) No. 2016-02 (Topic 842)*. Stamford, CT: FASB.

Fitó, M.Á., Moya, S., & Orgaz, N. (2013). Considering the effects of operating lease capitalization on key financial ratios. *Spanish Journal of Finance and Accounting / Revista Española de Financiación y Contabilidad*, 42 (159), 341–369.

Franz, D.R., HassabElnaby H.R., & Lobo, G.F. (2014). Impact of proximity to debt covenant violation on earnings management. *Review of Accounting Studies*, 19, 473–505.

Fülbier, R.U., Silva, J.L., & Pferdehirt, M.H. (2008). Impact of lease capitalization on financial ratios of listed German companies. *Schmalenbach Business Review*, 60 (2), 122–144.

Giner, B., & Pardo, F. (2017). Operating lease decision and the impact of capitalization in a bank-oriented country. *Applied Economics*, 49 (19), 1886–1900.

Goodacre, A. (2003). Operating lease finance in the UK retail sector. *International Review of Retail, Distribution and Consumer Research*, 13 (1), 99–125.

Imhoff, E.A., & Thomas, J. (1988). Economic consequences of accounting standards: The lease disclosure rule change, *Journal of Accounting and Economics*, 10: 277–310.

Imhoff, E.A., Lipe, R.C., & Wright, D.W. (1991). Operating leases: impact of constructive capitalization. *Accounting Horizons*, 5(1), 51–63.

International Accounting Standards Committee (1997). *International Accounting Standard No. 17: Leases*, IASB, London.

International Accounting Standards Board (2009). *Preliminary Views. Leases. DP/2009/01*. IFRS Foundation. March. London.

International Accounting Standards Board (2010). *Exposure Draft. Leases. ED/2010/9. IFRS Foundation*. August. London.

International Accounting Standards Board (2013). *Exposure Draft. Leases. ED/2013/6. IFRS Foundation*. May. London.

International Accounting Standards Board (2016a). *Leases. International Financial Reporting Standard No. 16*. IFRS Foundation. March. London.

International Accounting Standards Board (2016b). *Effects Analysis. IFRS 16 Leases.* IFRS Foundation. January. London.

Labro, E. (2015). Using simulation methods in accounting research. *Journal of Management Control,* 26, 99-104.

Mitchell, M.L., Stafford, E. (2000). Managerial decisions and long-term stock price performance. *Journal of Business*, 73 (3), 287-329.

Mody, A., Taylor, M.P. & Kim, J.Y. (2001). Modelling fundamentals for forecasting capital flows to emerging markets, *International Journal of Finance & Economics*, 6 (3), 201-216.

Mulford, C., & Gram, M. (2007). The effects of lease capitalization on various financial measures: An analysis of the retail industry. *Journal of Applied Research in Accounting & Finance*, 2 (2), 3–13.

Nelson, A.J. (1963). Capitalising leases: The effect on financial ratios. *Journal of Accountancy,* 41, 49–58.

Nikolaev, V.N. (2010). Debt Covenants and Accounting Conservatism. *Journal of Accounting Research*, 48 (1), 137–175.

Paik, D.G.H., van der Laan Smith, J.A., Lee, B.B., & Yoon, S.W. (2015). The relation between accounting information in debt covenants and operating leases. *Accounting Horizons*, 29 (4), 969–996.

Pastor, J.M., & Peraita, C. (2016). The Tax Returns of Public Spending on Universities: An Estimate with Monte Carlo Simulations, *Regional Studies*, 50 (11): 1863-1875.

PwC (2016). A study on the impact of lease capitalization: IFRS 16: The new leases standard. February.

Reher, G., & Wilfling, B. (2014). The valuation of European call options on zero-coupon bonds in the run-up to a fixed exchange-rate regime, *International Review of Economics and Finance* 29, 483–496.

Securities and Exchange Commission (SEC) (2005). *Report and recommendations pursuant to Section 401 (c) of the Sarbanes-Oxley Act of 2002 on arrangement with off-balance-sheet implications, special purpose entities, and transparency of filings by issuers*. Available at: http://www.sec.gov/news/studies/soxoffbalancerpt.pdf.

Simar, L., Wilson, P.W. (2000). Statistical Inference in Nonparametric Frontier Models: The State of the Art. *Journal of Productivity Analysis*, 13 (1), 49-78.

Valencia, A., Smith, T.J., & Ang, J. (2013). The effect of noisy fair value measures on bank capital adequacy ratios. *Accounting Horizons*, 27 (4), 693-710.

Table 1. Comparison between of the sample and EU listed companies

Panel A: Industry classification

	Stoxx All Europe 100	EU listed companies*
Mining; Construction	10.6%	7.5%
Manufacturing	60.6%	45.5%
Transportation, Communications, Electric, Gas & Sanitary Services	19.7%	11.7%
Wholesale Trade; Retail Trade	1.5%	9.9%
Real Estate	1.5%	3.9%
Services	6.1%	21.4%
TOTAL	100.0%	100.0%

Panel B: Descriptive statistics

	Stoxx All Europe 100		EU listed companies*	
	Mean	**Median**	**Mean**	**Median**
Total assets	70,286.050	42,757.945	2,606.469	243.123
Net sales	41,226.595	27,432.400	1,899.207	189.976
Leverage	0.597	0.600	0.542	0.548
Debt Quality	0.466	0.435	0.607	0.632
Liquidity	1.214	1.137	1.851	1.471
ROA	0.080	0.066	0.045	0.054
ROE	0.157	0.132	0.031	0.083

Note: * EU listed companies (excluded Stoxx All Europe 100 companies) with total assets figure exceeding €4 million and the net sales figure is higher than €8 million.

Table 2. Monte Carlo simulation procedure

Panel A: Probability distributions fitted to the stochastic variables of the model

Variable	Probability distribution	Variable	Probability distribution
CA	Mixture [{0.7627,0.2372},Gamma[2.231,5654.749],Uniform[{605.88, 92570.52}]}	e_{10}	Mixture [{0.8944,0.1055},{Cauchy [-1.8592,24.54376],LogNormal [5.1787, 0.7917]}]
e_1	Logistic [-136.961, 2755.486]	e_{11}	TStudent [54.3261, 34.7809, 0.9187]
e_2	Mixture [{0.641,0.359}, {Normal[1759.555, 5707.5003], Normal [19163.357, 18365.317]}]	e_{12}	Mixture [{0.7301,0.2698}, {Normal [-25.7460,21.9772], Normal [74.1128,203.9814]}]
e_3	Mixture [{0.845,0.154},{Cauchy[-2031.257,6400.134], Gamma [4.315,8109.457]}	e_{13}	TStudent [-8.6267,0.4338,0.3711]]
e_4	TStudent [-107.331, 1120.833, 1.406]	e_{14}	TStudent [1.8322, 4.6180, 0.778]
e_5	Mixture [{0.219,0.7806}, {Normal[1271.0358,10631.1130],Normal[-314.3649,1746.5288]}]	e_{15}	TStudent [-23.7401,46.8783, 1.0059]
e_6	Cauchy [3.0514, 26.1341]	e_{16}	TStudent [-10.2339,11.3516, 0.8417]
e_7	TStudent [5.2188,9.664, 0.829]	e_{17}	Weibull [0.6795, 186.4527, -199.8973]
e_8	Cauchy [5.6048, 15.6085]	e_{18}	Mixture [{0.6015,0.3984},{Normal[-133.9709,183.734501],Normal[202.4179, 1132.6557]}]
e_9	TStudent [4.992, 5.795,0.839]		

Panel B: Equations of OLS regression models

Dependent variable	OLS Equation	P-value	R^2
CL	$1117.67+(0.816546*CA)+e_1$	0.004	0.903
NCL	$3938.03+(1.07165*CL)+e_2$	0.000	0.643
NCA	$(33.4747*(NCL^{0.718125}))+e_3$	0.000	0.873
E	$(CA+NCA)-(CL+NCL)$		
¿	$573.106+(0.109552*E)+e_4$	0.000	0.334
$EBIT$	$2552.22+(0.765167*¿)+e_5$	0.000	0.432
$mlp(1)$	$-24.4064+(0.0317034*CA)+e_{18}$	0.000	0.389
$mlp(2)$	$(0.684485*(mlp(1)^{0.987768}))+e_6$	0.000	0.949
$mlp(3)$	$(0.953904*(mlp(2)^{0.994356}))+e_7$	0.000	0.989
$mlp(4)$	$(0.876323*(mlp(3)^{1.0034}))+e_8$	0.000	0.981
$mlp(5)$	$(0.900753*(mlp(4)^{1.00834}))+e_9$	0.000	0.989
$mlp(6)$	$(0.462814*(mlp(5)^{1.06051}))+e_{10}$	0.000	0.737
$Vmlp(1)$	$-80.8699+(0.551304*mlp(1))+e_{11}$	0.000	0.844
$Vmlp(2)$	$28.604+(0.0751225*Vmlp(1))+e_{12}$	0.000	0.149
$Vmlp(3)$	$8.72319+(0.972717*Vmlp(2))+e_{13}$	0.000	0.771
$Vmlp(4)$	$-1.18971+(0.69368*Vmlp(3))+e_{14}$	0.000	0.767
$Vmlp(5)$	$42.6296+(1.30546*Vmlp(4))+e_{15}$	0.000	0.184
$Vmlp(6)$	$7.90459+(0.125027*Vmlp(5))+e_{16}$	0.000	0.112
$Vmlp(9)$	$220.072+(1.1367*Vmlp(6))+e_{17}$	0.000	0.098

Notes: $CA_{\square}$ is current assets; $NCA_{\square}$ is non-current assets; $CL_{\square}$ is current liabilities; $NCL_{\square}$ is non-current liabilities; $E_{\square}$ is equity. Regarding lease payments, we define $mlp(t)_y$ as the minimum lease payments in time

t for all the lease contracts existing in year y and $Vmlp(t)$ as its annual variation ¿).

Table 3. Evolution of the ratios under the simulated scenarios.

Panel A: Base scenario (ratios and variation)

Year	Leverage		Debt Quality		Liquidity		ROA		ROE	
2019-2023*	0.6395	**Var.**	0.3727	**Var.**	1.3547	**Var.**	0.0753	**Var.**	0.1252	**Var.**
2019	0.6657	4.1%	0.3530	-5.3%	1.1880	-12.3%	0.0707	-6.2%	0.1304	4.1%
2020	0.6676	4.4%	0.3566	-4.3%	1.1805	-12.9%	0.0701	-7.0%	0.1304	4.2%
2021	0.6687	4.6%	0.3522	-5.5%	1.1533	-14.9%	0.0695	-7.7%	0.1304	4.1%
2022	0.6693	4.7%	0.3590	-3.7%	1.1587	-14.5%	0.0698	-7.3%	0.1304	4.1%
2023	0.6687	4.6%	0.3596	-3.5%	1.1374	-16.0%	0.0719	-7.3%	0.1304	4.1%

* First row presents the simulation results applying IAS 17 (before capitalization); other rows present the simulation results applying IFRS 16 (after capitalization). *Var.* is the percentage of variation measured with respect to data in the first row for each ratio.

Panel B: Other future scenarios (variation)

Scenario (*i*)

Year	Leverage	Debt Quality	Liquidity	ROA	ROE
2019	4.1%	-4.0%	-12.2%	-6.5%	4.7%
2020	4.2%	-4.0%	-12.8%	-7.1%	4.1%
2021	4.1%	-3.2%	-14.6%	-7.4%	3.4%
2022	4.0%	-2.3%	-15.3%	-7.6%	2.7%
2023	3.9%	-0.8%	-16.6%	-7.5%	2.3%

Scenario (*ii*)

Year	Leverage	Debt Quality	Liquidity	ROA	ROE
2019	3.2%	-2.3%	-12.4%	-6.0%	3.6%
2020	3.3%	-2.1%	-12.8%	-6.2%	2.3%
2021	3.3%	-1.1%	-14.4%	-6.2%	2.2%
2022	3.3%	0.1%	-15.3%	-6.2%	2.1%
2023	3.1%	1.9%	-16.5%	-6.0%	1.9%

Scenario (*iii*)

Year	Leverage	Debt Quality	Liquidity	ROA	ROE
2019	3.9%	-4.3%	-11.5%	-6.0%	4.2%
2020	4.1%	-4.4%	-11.8%	-6.5%	4.1%
2021	4.2%	-3.9%	-13.4%	-6.7%	3.9%
2022	4.4%	-3.9%	-13.5%	-6.9%	3.8%
2023	4.2%	-3.7%	-14.2%	-6.6%	3.7%

Scenario (*iv*)

Year	Leverage	Debt Quality	Liquidity	ROA	ROE
2019	3.7%	-4.3%	-10.7%	-5.8%	4.1%
2020	3.7%	-4.3%	-11.0%	-6.2%	3.8%
2021	3.8%	-3.8%	-11.9%	-6.1%	3.6%
2022	3.8%	-3.0%	-12.4%	-6.1%	3.4%
2023	4.0%	-2.8%	-12.9%	-6.3%	3.2%

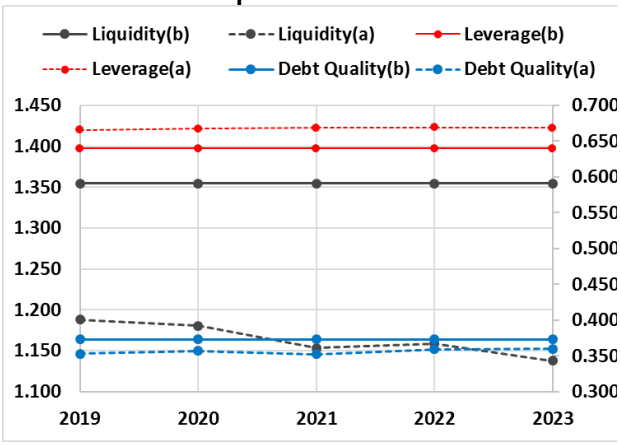
The percentage variation is measured with respect to the simulation results applying IAS 17 for each scenario (first row in Panel A).

Table 4. Mathematical formulation of $mlp(t)$ in scenario (*i*) and in scenario (*ii*)

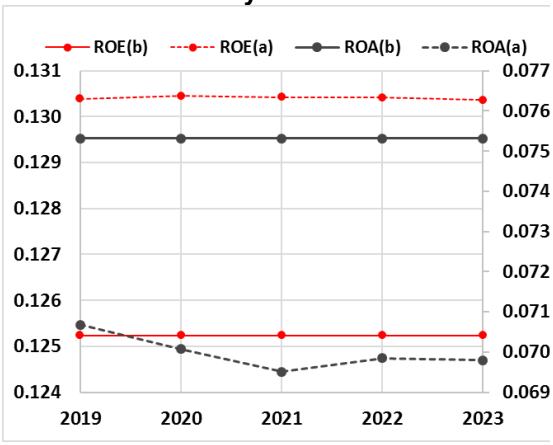
Year	$mlp(5)$	$mlp(6)$	$mlp(7)$	$mlp(8)$	$mlp(9)$
		scenario (*i*)			
2019	$mlp(6)_{18}+Vmlp_5(i)$	$mlp(7)_{18}$	$mlp(8)_{18}$	$mlp(9)_{18}$	0
2020	$mlp(6)_{19}+Vmlp_5(i)$	$mlp(7)_{19}$	$mlp(8)_{19}$	0	0
2021	$mlp(6)_{20}+Vmlp_5(i)$	$mlp(7)_{20}$	0	0	0
2022	$mlp(6)_{21}+Vmlp_5(i)$	0	0	0	0
2023	$Vmlp_5(i)$	0	0	0	0
		scenario (*ii*)			
2019	$mlp(6)_{18}+Vmlp_5(i)$	0	0	0	0
2020, 2021, 2022, 2023	$Vmlp_5(i)$	0	0	0	0

Figure 1. Results of the Monte Carlo model from 2019 to 2023, for data before (b) and after (a) lease capitalization

Panel A: Financial position ratios



Panel B: Profitability ratios

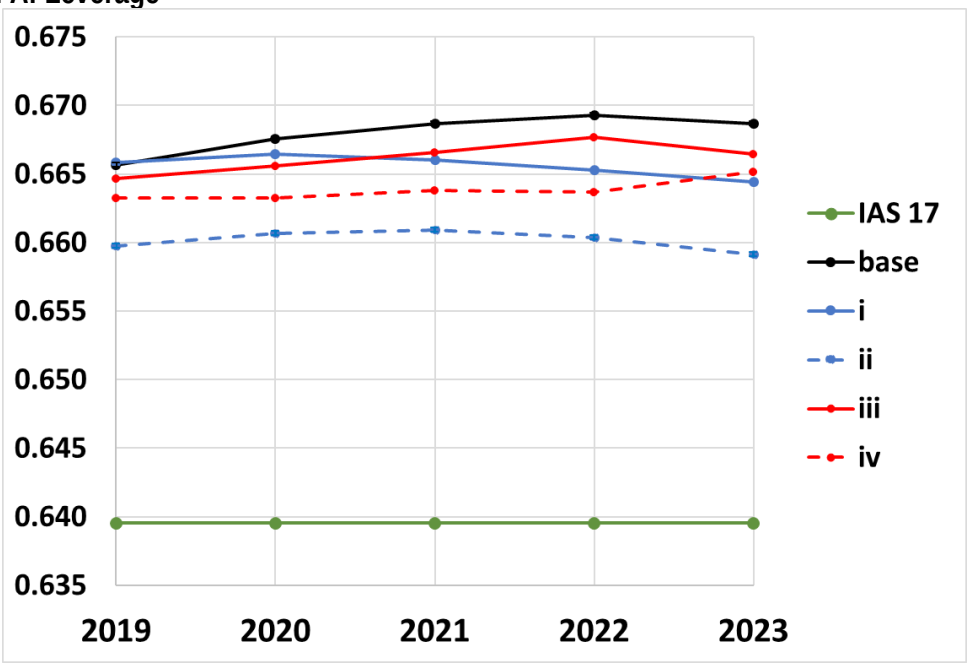


Panel A: Liquidity (left axis), Leverage (right axis) and Debt Quality (right axis) ratios.

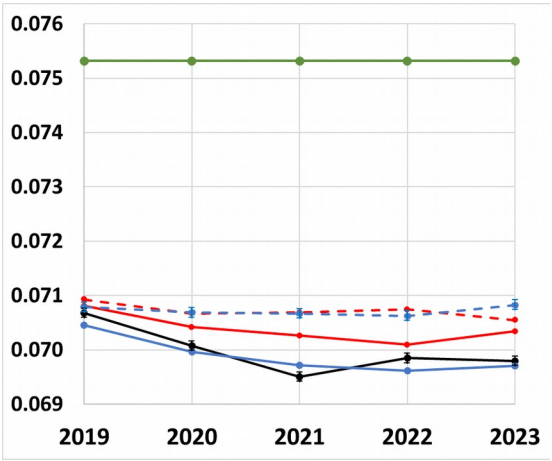
Panel B: Results for financial (ROE, left axis) and economic (ROA, right axis) profitability ratios.

Figure 2. Annual ratios from 2019 to 2023, before (IAS 17) and after lease capitalization for all scenarios (base, (*i*), (*ii*), (*iii*), (*iv*)). The 95% Confidence Intervals (CI) are only represented for base and (*ii*) scenarios.

Panel A: Leverage



Panel B: ROA



Panel C: ROE